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ABSTRACT

This paper comments on Gagne's classification scheme with respect to learning outcomes, and offers a research design appropriate for instructional research studies. It challenges certain assumptions concerning correspondence between subject matter and categories, and asserts that the logic of experimental analysis should be applied to instructional research. The paper stresses the importance of systematic analysis of test stimuli in relation to instructional stimuli, in order to distinguish between learning and retentior or transfer of training. (Author)

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COMMENTS ON PROFESSOR GAGNE'S PAPER ENTITLED "INSTRUCTIONAL VARIABLES AND LEARNING OUTCOMES"

Richard Anderson

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Center FOR THE Study of Evaluation OF INSTRUCTIONAL PROGRAMS

University of California, Los Angeles, September 1968

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COMMENTS ON PROFESSOR GAGNÉ'S PAPER ENTITLED "INSTRUCTIONAL VARIABLES AND LEARNING OUTCOMES"

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From the Proceedings of the

SYMPOSIUM ON PROBLEMS IN THE EVALUATION OF INSTRUCTION

University of California, Los Angeles
December, 1967

M. C. Wittrock, Chairman

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Richard Anderson

Since I find myself in substantial agreement with Professor Gagné, my remarks will be more an extension of what he said than a critique.

I have three kinds of comments to make. First, I shall comment on Gagné's classification scheme with respect to the varieties of learning outcomes. Second, I shall try to give concrete illustrations of what I regard as the main theme of his paper; and third, I shall comment on an appropriate kind of research design for instructional research studies. My remarks will generally have more directly practical implications than either Professor Gagné's or Professor Postman's remarks.

I would like you to assume that some students have received a verbal lesson and that some tests that have entirely verbal content are given. Now, it would be said by a specialist in the subject matter of the discipline being taught that the lesson contains statements, some of which are descriptions and definitions. Other statements would be said to express concepts and principles.

In his hierarchical classification Robert Gagné has described such categories as S-R connections, simple chains, concepts, and principles. It is tempting to believe that there is a one-to-one correspondence between the statements in the subject matter, that is, in the object discipline, and the categories in Gagné's system.

My first point is that we certainly cannot assume such a one-to-one correspondence, and I am not trying to suggest that Gagné implied that we could. In fact, I think the whole point of his paper was that we cannot take statements from an object discipline and characterize them on the basis of an inspection of the statements alone. Let us be specific. A botanist might, in the course of a lecture, make the following two kinds of assertions: (a) "Palmate leaves are hand shaped," and (b) "Gene pools tend to remain stable over time." He might regard the first statement as a definition or a descriptive statement; he might regard the latter as a broad principle, a cornerstone of his discipline. We cannot assume in terms of Gagné's classification scheme that the definitional statement is learned as an S-R connection or a simple chain and that the botanist's principle is learned as a principle in Gagné's sense. Both or neither of the statements in the discipline could be learned as simple S-R connections or as principles. I fear that Professor Gagné has been widely misunderstood on this point. Educators from various subject matter areas try to match what they call concepts and what they call principles with the categories so designated in his system. Hereafter when I use the word "principle," I will be referring to a statement in the subject matter being taught.

My second comment deals with what I regard as the main theme of Gagné's paper: namely, that we should be applying the logic of experimental analysis to instructional research, most particularly

to evaluation and assessment problems. This is a position which I heartily endorse. What I want to do today is to make concrete some of Gagné's suggestions.

Consider first the distinction between the instructional stimulus and the test stimulus. This is the distinction upon which depends the differentiation between learning and retention, on the one hand, and transfer of training on the other hand. Test items which entail verbatim repetition of an instructional stimulus can easily be distinguished from items that entail paraphrases or transformations of the verbatim statement as it appeared in instruction. In other words, the instructional statements and statements in test items can be stated in different words which will be judged to mean the same thing by a person who is an expert in the appropriate discipline.

It will be said by a person operating within a subject matter that principles and concepts apply to classes of examples or instances. A test item may repeat an example included within instruction, or it may involve a new example not included within instruction.

We have here, simply, the difference between lack of understanding and understanding--a person who "knows" a principle can perform in a manner consistent with the principle, no matter what words are employed to express it. A person who "understands" a concept should be able to correctly classify new instances which he did not encounter during the course of a lesson. Technically, the distinction between an instructional stimulus and a test

stimulus is a prerequisite for distinguishing between transfer of training and learning or retention.

Several other distinctions can be made. Within instruction we cannot easily distinguish between the stimulus and the response, but we can make this distinction with respect to test items. For example, one can present the definition of a technical term within an item stem and call for the technical term from the student, or one can give the technical term as the test stimulus and call for the definition from the student.

Test items can be distinguished in terms of whether the student must <u>select</u> an alternative--as in a multiple choice item--or <u>supply</u> the response word or phrase--as in completion items. Evidence is beginning to accumulate in my laboratory and elsewhere that the response mode of test items interacts with instructional variables.

A variety of kinds of item types can be generated by applying simple operations of the sort outlined above to instructional statements. Figure 1 illustrates the items that may be obtained (a) by varying the segment of the instructional statement which comprises the test stimulus, (b) by allowing either a constructed or selected response from the student, (c) by including verbatim or transformed instructional statements, and (d) by employing repeated examples or new examples. I do not mean to suggest that this analysis is complete; however, it should be possible to develop a taxonomy of kinds of test items by making distinctions such as I have made.

Figure 2 lists kinds of information about testing procedures that people performing instructional research could provide. In

the second column is my guess as to how frequently this information is indeed provided. I shall comment briefly on the fourth entry regarding "Test Development Procedure." The psychometrician reigns supreme here. When there is any talk of how achievement tests are developed, there is usually talk of selecting items in terms of difficulty levels, item-total correlations, and discriminating power. I think the thrust of Gagné's analysis is that the first order of business is a qualitative and a logical analysis, that the discriminating power of items should be given zero weight until the qualitative and logical questions have been satisfactorily answered. Then, with what freedom remains, there presumably is no objection to optimizing discriminating power.

With respect to the fifth entry, "Assumed Level of Psychological Process," the implication of this analysis is that one can make no statement about psychological process without a consideration of experimental operations, control operations, and measurement operations. Distinctions between processes depend upon experimental design. Such distinctions cannot be made from inspection of the test items alone.

Finally, I shall claim that most instructional research should involve a transfer of training design. When we talk as Gagné does about concepts and principles, we imply transfer of training as an underlying process. When we talk about analysis and synthesis, such as Bloom and his associates have done, once again transfer of training is implicated.

Educators generally hope that the student will be able to deal with new configurations of material different from those he

encountered during instruction. Transfer of training is usually a goal of instruction. Two-stage measurement of the sort that Professor Gagné is suggesting seems necessary to distinguish between learning and transfer. To be determined at the first stage is whether the student can deal successfully with verbatim statements and examples from the lesson. Then, at the second stage, it is determined whether he can handle transformed statements of principles and new examples of the principles hopefully taught within the lesson. With respect to two-stage measurement, there is at least one complicating consideration: the possible reactive effects of testing. There can be a facilitative effect from merely working through a sequence of items. Split-sample designs, in which some students get some items and other students get other items, could be used to control for facilitation due to repeated exposure to similar test items.

In conclusion, the one point that I wish to stress is the importance of systematic analysis of test stimuli in relation to instructional stimuli. The distinction between learning or retention and transfer of training cannot be made without such analysis.

Figure 1

ITEM TYPES GENERATED IN AN ANALYSIS OF PRINCIPLE STATEMENTS IN AN OBJECT DISCIPLINE

Prototype	Sample item
1A. Given the verbatim statement of a principle, the student can supply the name of the principle.	1A. Behavior which leads to a satisfying state of affairs is strengthened. Behavior which leads to an annoying state of affairs is weakened. The principle is called_____.
1B. Given a verbatim statement of the principle, the student can select the name of the principle.	1B. Behavior which leads to a satisfying state of affairs is is strengthened. Behavior which leads to an annoying state of affairs is weakened. This principle is called: a) The Law of Effect b) The Law of Contiguity
2A. Given a transformed statement of the principle, the student can supply the name of the principle.	2A. Rewarded responses tend to be repeated. Punished responses tend to be suppressed. This principle is called_____.
2B. Given a transformed statement of the principle, the student can select the name of the principle.	2B. Rewarded responses tend to be repeated. Punished responses tend to be suppressed. This principle is called: a) The Law of Effect b) The Law of Contiguity
3A. Given the name of the principle, the student can supply the verbatim statement of the principle.	3A. Define the Law of Effect (in Thorndike's words).
3B. Given the name of the principle, the student can select the verbatim statement of the principle.	3B. Which of the following is the best definition of the Law of Effect? a) Behavior which leads to a satisfying state of affairs is strengthened. Behavior which leads to an annoying state of affairs is weakened. b) When a neutral stimulus is repeatedly paired with an unconditioned stimulus,

the former stimulus acquires the power to evoke the conitioned response.

4A. Given the name of the principle, the student can supply a transformed statement of the principle.

4A. Explain the Law of Effect in your own words.

4B. Given the name of the principle, the student can select a transformed statement of the prinple.

4B. Which of the following is the best definition of the law of Effect?

a) Rewarded responses tend to be repeated while punished responses tend to be suppressed.

b) Any stimulus can become a "signal" for second stimulus if the first one accompanies or slightly precedes the second one enough times.

5A. Given an example included within training, the student can supply the statement of the principle.

5A. A pigeon receives a pellet of food for some but not all of the pecks it makes on an illuminated key. When the food is terminated, the pigeon continues to peck the key for a number of hours. Explain what has happened in technical, psychological terms.

5B. Given an example included within training, the student can select the statement of the principle.

5B. A pigeon receives a pellet of food for some but not all of the pecks it makes on an illuminated key. When the food is terminated, the pigeon continues to peck the key for a number of hours. Which of the following is the best explanation of what has happened?

a) Keypecking behavior has been reinforced intermittently with food: therefore, the behavior is resistant to extinction.

b) The previously neutral stimulus, the illuminated key, has acquired the power to evoke keypecking behavior which, therefore, continues when food is terminated.

6A. Given a <u>new</u> example, the student can <u>supply</u> the statement of the principle.	6A. Mr. Jones has had frequent trouble starting his car. Sometimes it starts immediately. Sometimes it doesn't. On one particular occasion it fails to start immediately. Mr. Jones continues to try to start his car for nearly a half an hour before calling a taxi. Explain what has happened in technical, psychological terms.
6B. Given a <u>new</u> example, the student can <u>select</u> a statement of the principle.	6B. Mr. Jones has had frequent trouble starting his car. Sometimes it starts immediately. Sometimes it doesn't. On one particular occasion, it fails to start immediately. Mr. Jones continues to try to start his car for nearly a half an hour before calling a taxi. Which of the following is the best explanation of what has happened? a) Attempts to start the car have been reinforced intermittently; therefore, this behavior is resistant to extinction. b) A previously neutral stimulus, the car's starter, has acquired the power to evoke starting behavior; therefore, attempts to start the car continue even when it fails to start immediately.
7A. Given a statement of a principle, the student can <u>supply</u> an example <u>included during training</u>.	7A. Intermittent reinforcement causes resistance to extinction. Give a concrete example of this principle (which appeared in your reading).
7B. Given a statement of a principle, the student can <u>select</u> an example <u>included during training</u>.	7B. Intermittent reinforcement causes resistance to extinction. Which of the following best illustrates this principle? a) A pigeon occasionally receives food when it pecks an illuminated key. When food is no longer given, the pigeon continues to peck the key for a number of hours.

b) Shortly after a buzzer sounds, a dog is shocked unless it jumps over a barrier. After the shock is discontinued, the dog continues to jump when the buzzer sounds for a number of hours.

8A. Given a statement of a principle, the student can <u>supply</u> a <u>new</u> example.

8A. Intermittent reinforcement causes resistance to extinction. Give a concrete example of this principle which was <u>not</u> included in your reading.

8B. Given a statement of a principle, the student can <u>select</u> a <u>new</u> example.

8B. Intermittent reinforcement causes resistance to extinction. Which of the following best illustrates this principle?

a) As the number of hours since the baby was last fed increases, the frequency and intensity with which it cries are observed to increase.

b) In order to keep him quiet, Mrs. Jones sometimes gives her son candy when he throws a tantrum. She stops this practice on the advice of a psychologist; however, the tantrums are observed to continue.

j. Given a <u>new</u> example of the antecedent of a principle, the student can <u>supply</u> the consequent.

j. A person selling life insurance will make a sale to only a small proportion of the prospects he contacts. Describe the probable behavior of a seasoned life insurance salesman who fails to sell a policy for a number of days.

k. Given a <u>new</u> example of the consequent of a principle, the student can <u>supply</u> the antecedent.

k. A seasoned life insurance salesman fails to sell a policy for a number of days. Nonetheless, he continues to make contacts in the attempt to sell. Suggest in concrete terms a possible explanation of why he continues to try to sell instead of, for instance, taking another job.

Figure 2

WHAT INFORMATION IS PROVIDED REGARDING TESTING PROCEDURE IN PUBLISHED REPORTS OF INSTRUCTIONAL RESEARCH?

	Type of Information	Frequency
1.	Response mode	Always
2.	Number of items	Usually
3.	Internal consistency reliability	Often
4.	Test development procedure item difficulty part-whole correlation	Often
5.	Assumed level of psychological process	Occasionally
6.	Topical content analysis with number of items per topic	Rarely
7.	Systematic analysis of test items in relation to instructional content	Never